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PELAGIC LARVAE OF GASTROPOD MOLLUSKS OF THE BLACK SEA*

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Introduction

Larvae of gastropod mollusks appear as a substantial component of the plankton, reaching enormous numbers during the summer months. However, the pelagic larvae of gastropods in the Black Sea have been little known both as to taxonomy and ecology. A description of the larvae of Nassa reticulata is given in the work of Bekman (1941). Some information about the reproduction of several species of gastropods is presented in the work of Vinogradova (1950), but, unfortunately, the author gives no descriptions of the larvae. Aside from these, there is no literature on the pelagic larvae of gastropod mollusks. Works are available on larvae of other seas: The major ones by Thorson (1946), Lebour (1937), and Rasmussen (1944) do not entirely apply to the Black Sea, since larvae may undergo morphological change in different areas of their distribution. The literature supplies no descriptions of the larvae for considerable numbers of the gastropods encountered in the Black Sea. Because of this poor state of information, the pelagic larvae of Black Sea gastropods remain unidentified in works on the plankton. Our work, without claiming completeness, is aimed at assisting planktologists in identifying the pelagic larvae of gastropods encountered in the plankton of the Black Sea.

The lower gastropods discharge eggs directly into the water where development occurs. This method of depositing eggs is seen in Patella pontica, Phasianella ponticum, and Gibbula divaricata. In other gastropods, eggs are deposited either in mucous masses or in capsules. The gastropods can be divided into three groups depending on the method of development:

1. Mollusks in which all development takes place within the egg or capsule, the young emerging as completely formed mollusks. Among

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* All measurements are in microns unless otherwise indicated.

the Black Sea gastropods, this kind of development is observed in Cyclonassa neritea, C. kamyshensis and Caliptrea chinensis (Vinogradova, 1950). In our work we have obtained directly from the capsule young of Hydrobia ventrosa and Setia valvatoides. According to Lebour (1937), Omalogyra atomus (Philippi), in the vicinity of Plymouth, deposits egg capsules inside the maternal shell; young mollusks emerged from the capsule. Possibly in the Black Sea Omalogyra atomus uses this method of reproduction. Without doubt, it has no pelagic larvae in the Black Sea. Also, in Trophon breviatus the diameter of the first whorl of the shell of the young mollusk is very large (500) and its egg capsules contain a small number of very large eggs (380).

2. Mollusks with pelagic larvae which live for a very short time in the plankton and are nourished by their yolk (lecithotrophic larvae). Here belong Patella pontica, Phasianella pontica, Gibbula divaricata, G. albida, G. euxinica.

3. Mollusks whose pelagic larvae live a long time in the plankton and are nourished by plankton. Here belong the majority of mollusks making up the main mass of larvae occurring in the plankton.

During the first stages, pelagic larvae of gastropods are trochophores. However, the typical trochophore appears only in the primitive forms (Patella, Phasianella, Gibbula). Most marine gastropods go through the trochophore stage within the egg membrane and emerge from the egg as an already well-formed veliger--the second stage in the development of pelagic larvae.

In our present work we give descriptions of veligers of gastropods that had emerged from egg masses and capsules. Descriptions of later stages of veligers are based on larvae collected in the plankton and kept in Petri dishes through development and transformation into young mollusks.

Larvae of 16 species are described for the first time, larvae of eight species are described from literature about other seas; two are described under generic names only; and two could not be identified and are described under temporary names. Corrected descriptions are compiled for three species of Black Sea gastropods from data given in the literature.

Gibbula albida (Gmelin)

G. albida was bred in our aquarium at the end of May. It deposits its eggs in a large, very loose and unstable, irregular, gelatinous mass. Eggs are white, covered with a transparent membrane. Diameter of eggs is 150, diameter including membrane 200. Larvae (Fig. 1a) emerge from the egg mass after three days at a temperature of 20°.

The shell of larvae emerging from the egg mass is not coiled. The height of the shell is 270. The edge of the aperture of the

shell is raised like a collar. The shell is transparent, colorless, and smooth. The velum of the larva is not separated into lobes and has the appearance of a continuous ciliary ring. The foot is fairly large with an operculum. Larvae are lecithotrophic, having a large yolk reserve; the digestive system is not formed. The soft body of the larva is white. The period of pelagic existence is very short. Larvae settle to the bottom on the day after emerging from the egg mass. There is no information in the literature about the reproduction of G. albida.

Gibbula euxinica (Andrjewski)

We bred G. euxinica in the aquarium during April and May. The mollusks deposit transparent mucous masses of irregular shape which are attached to the substrate. Egg masses measure 8-10 mm. Eggs are white, rich in yolk, covered with a transparent membrane and enclosed in a common mucous mass. The diameter of the egg is 130; the diameter with membrane is 160. Pelagic larvae (Fig. 1♂) emerge from the egg mass in five days at 17-18°.

The shell of the larva (Fig. 1♀) freshly hatched from the egg mass is not coiled but is sometimes constricted laterally. Height of the shell is 240, diameter 210. The edge of the aperture of the shell is slightly raised, appearing like a low collar. The shell is transparent, colorless, with irregular disconnected dark spots. The velum of the larva is not separated into lobes and has the appearance of a continuous ciliary ring. The foot of the larva is large with an operculum.

Larvae are lecithotrophic, having a large supply of yolk. The digestive system is not formed. The soft body of the larva is white.

The larvae live in the plankton a very short time. In our tests they settled on the day after emergence from the egg mass. There are no data in the literature about the reproduction of G. euxinica.

Gibbula divaricata Linné

Information about reproduction and development of G. divaricata is given by Vinogradova (1950). G. divaricata discharges eggs into the water, where fertilization takes place. Eggs are light-green, separate, comparatively light, with a diameter of 160. The female forcibly discharges eggs in a stream, extruding them upward. Development is very rapid and larvae appear after only 12 hours--veligers having a shell size of about 200. However, Vinogradova does not give descriptions of larvae of G. divaricata. We were able to obtain eggs of G. divaricata in July, but the eggs did not develop and died.

Phasianella pontica Milaschewitsch

Larvae of P. pontica (Fig. 2) in Sevastopol Bay occur in plankton samples collected from May to November. At Karadag, according to the data of Vinogradova, larvae of P. pontica are found from June to September. P. pontica discharges pelagic eggs. Eggs are green, with a diameter of 150.

Completely grown larvae of P. pontica have a velum in the form of a simple ciliated ring, not divided into lobes; the velum is greenish. The shell is colorless, its aperture like a high collar. Height of the shell is 240, breadth 120. A very large part of the body of the larva has a yellow-green color. The digestive system is not developed and the larva is lecithotrophic. The period of pelagic existence is very short. Larvae of P. pontica transferred from the plankton during the stage described above settle on the bottom of a dish and begin to creep and go through to a benthonic stage of life after 1-2 days. Larvae of P. pontica are not described in the literature.

Patella pontica Milaschewitsch

Zernov (1913) wrote that P. pontica at Sevastopol reproduces in winter. Our observations corroborate the winter reproduction of P. pontica at Sevastopol; in summer gonads of the mollusks are empty. However, Vinogradova (1950) found that at Karadag P. pontica reproduces in summer.

Vinogradova writes that P. pontica discharges eggs directly into the water. Eggs have a diameter of 160 and a brownish tint. They are comparatively rich in yolk and are furnished with a thin membrane.

Development of the larvae proceeds very quickly and the veliger soon settles. Vinogradova gives no description of the larvae.

Littorina neritoides Linné

L. neritoides lives on rocks drenched by surf but not submerged in the water. In view of the air habit of this mollusk, it might be supposed that L. neritoides is viviparous. So it was considered earlier. However, in 1935 it was discovered simultaneously by Linke (1935) and Lebour (1935) that L. neritoides deposits pelagic egg capsules.

In the North Sea, according to Linke, L. neritoides reproduces in winter and spring. In Sevastopol L. neritoides is found with ripe gonads from December to April. We obtained egg capsules in aquaria in December.

L. neritoides lays planktonic egg capsules. The capsules are lens-shaped, rounded on both sides, one side more rounded than the other. Along the edge of the capsule is a narrow little groove. The diameter of the capsule, according to Lebour, is 160-180, according to Linke 200-270. In Sevastopol the diameter of the capsule was 200. Each capsule contains one egg, which is covered by a membrane and floats in the capsule. The diameter of the egg is 80-90.

We did not succeed in hatching larvae from the egg capsules. According to Linke and Lebour, at the time of hatching, the veliger of L. neritoides (Fig. 3) has a shell of 1 1/4 whorls, a large foot, and two otoliths; the shell has spiral lines with dots between them; the velum is devoid of pigment.

Rissoa splendida Eichwald

R. splendida at Sevastopol breeds almost the whole year, except in July and August. R. splendida occurs in great numbers among the seaweed Cystoseria on which it deposits the majority of its egg capsules. Capsules (Fig. 4 *a*) are lens-shaped, very thin-walled, and leathery, fastened by the flattened surface to the substrate. The walls of the capsule are transparent and colorless. In the center of the upper surface the capsule is thinner and here the larva emerges upon hatching. The diameter of the capsule is 1.2-1.3 mm. Eggs are white, with a diameter of 70-80. Planktonic larvae emerge from the capsule after eight days.

At emergence, the larvae of R. splendida (Fig. 4 *б* and *в*) have transparent, smooth and colorless shells with one whorl. The height of the shell is 170. The shell has a characteristic spiral banding. The top of the aperture of the shell is rostrate. In larvae of Rissoa the rostrum is smaller than in larvae of Bittium reticulatum.

The velum of the larva is bilobed and colorless. The digestive system is completely formed; esophagus, stomach, and gut are colorless; the liver is large, yellow with large fat drops. The foot is colorless and the end of the foot blunt.

At a stage of 1 1/2 whorls, the diameter of the larval shell is 230. The liver of the larva is yellow or greenish. At the base of the coil of the shell appear spiral bands. The outer lip of the shell is drawn out into a small "rostrum." The velum is bilobed, with a band of lilac pigment along its edge. Under this appears an accumulation of green pigment. There is green pigment on the foot.

Larvae with shells of 2 1/2 whorls (Fig. 4 *г* and *д*) are found in the plankton in large numbers. The shell of these larvae is transparent, smooth, colorless, with a diameter of 290. The velum is bilobed and along its edge runs a narrow band of brownish-black pigment. Under this band is a second, narrower band consisting of an

accumulation of grains of green pigment. An especially dense accumulation of pigment is seen in this lower band of the velum. The larvae have two tentacles of equal size, and on the foot are two secondary protuberances. At the top of the secondary protuberances of the foot and in the center of the foot appears black pigment. The foot is green, the liver green or yellow-brown. The base of the shell is brownish-reddish. There is a small, posterior protuberance on the foot. In the literature there is no description of the larvae of R. splendida.

Rissoa venusta Philippi

R. venusta (Fig. 5) occurs all year at Sevastopol. It appears in abundance and is found in huge numbers, especially on Zostera. Also on Zostera it is possible to find egg masses of R. venusta. The egg masses are enclosed in a lens-shaped, very thin-walled capsule, fastened by the flat surface to the substrate. The walls of the capsule are transparent and colorless; in the center of the upper surface the capsule is very thin and here the larvae emerge on hatching. The diameter of the capsule is 0.7-1.2 mm. Eggs are white, with a diameter of 70-80.

On emerging from the egg capsule, the larva has a transparent, smooth, and colorless shell with one whorl; the height of the shell is 170-180. The shell lacks the spiral groove characteristic of R. splendida. The velum is bilobed and small; on its posterior edge is a band of black pigment, and under this are scattered disconnected granules of green pigment. The digestive system is completely formed; esophagus, stomach, and gut are colorless; the liver is large and yellow with large fat drops. The foot is colorless, the end blunt. It has two large eyes, two otoliths and one true tentacle.

Before settling, the larva of R. venusta has a colorless, transparent shell with 2 1/2 whorls. The diameter of the shell of such a larva is 300-320, the velum bilobed and colorless, and the foot blunt with two lateral protuberances lacking any pigment. The posterior protuberance characteristic of late larvae, especially in young R. splendida and R. euxinica, is lacking in R. venusta.

Rissoa euxinica Milaschewitsch

We have seen reproduction of R. euxinica in the aquarium in May. Eggs are in lens-shaped, very thin-walled, leathery capsules fastened by the flat surface to the substrate. The diameter of the capsule is 700-800. Eggs are white and 67 in diameter.

On emergence from the capsule, the larva has a transparent, smooth, colorless shell with one whorl. The height of the shell is 160, diameter 120. The shell lacks the spiral bands characteristic of R. splendida. The velum is bilobed, small, colorless; between the

two lobes of the velum are two large green-chestnut spots. The digestive system is well developed; esophagus, stomach and gut are colorless; liver is large, yellow with large fat drops. The tip of the foot is blunt, with four chestnut-green spots. There are two large eyes, two otoliths, and one true tentacle. In the literature there is no description of the larva of R. euxinica.

Cerithidium submammelatum (Rayn et Ponzi)

C. submammelatum bred in our aquaria in April. Egg masses have the appearance of white mucous strings 2-3 mm long. Eggs are white, with a diameter of 60. Eggs are covered with a transparent membrane; the diameter of the eggs with membrane is 105. Eggs are deposited in a communal mucous mass. Larvae hatch from the mass after eight days.

On emergence from the egg mass, the larva has a shell of one whorl, with a diameter of 120 (Fig. 6). After three to four days, the outer lip of the shell is expanded into a "rostrum." The apex of such a larva is reddish-brownish with a dark narrow collar. The collar in C. submammelatum is considerably narrower than in Bittium reticulatum. The shell is broad, less compressed along the sides than in Bittium reticulatum, smooth and transparent. The velum is bilobed and colorless. The digestive system is well developed. There are no descriptions of the larvae of C. submammelatum in the literature.

Cerithiopsis tubercularis Montagu

Larvae of C. tubercularis (Fig. 7) with four shell whorls are found in plankton samples collected in Sevastopol Bay in July, August and September. We have not found young larvae with fewer whorls in the plankton. According to Lebour (1933a), a young larva with a shell of 2 1/2 whorls has on the outer lip of the shell a plate-like outgrowth, on which appear concentric layers of growth with rows of dots between them. The height of the shell is 240, color brownish. The velum is bilobed and colorless.

In later larvae with four shell whorls, the outer lip of the shell takes on a mushroom shape. In the Plymouth area the height of a shell having 4 to 4 1/2 whorls, according to Lebour, reaches 640. With us, larvae of four whorls are smaller, 410-450. Shells of such larvae are transparent, slightly brownish, and quite smooth. The whorls of the shell are somewhat convex. The velum is bilobed and colorless; the foot is large, pointed posteriorly.

Cerithium ponticum Milaschewitsch

C. ponticum reproduced in our aquarium in June. Egg masses have the appearance of a long, coiled string, the length of which reaches 60 cm, the width 1.5 to 2.0 mm. The coil itself consists of a thin string, a mucous fringe. The width of this thin string is 0.40-0.47 mm. The eggs are white with a diameter of 74. Eggs are covered with a transparent membrane; diameter of the egg with membrane is 130. Larvae emerge from the egg mass at a temperature of 22° after four days.

On emergence from the egg mass, the larva has a colorless shell with one whorl, height 130-140 (Fig. 8). The surface of the shell is studded with fine, irregularly scattered dots. After 3-4 days, a "rostrum" develops in the larvae on the outer edge of the shell; on the base of the shell are brownish bands. The velum is bilobed and colorless. The foot is blunt. The digestive system is completely formed. The stomach is large and rounded. The two lobes of the liver are of equal size. We have not found a description of the larvae in the literature.

Triphora perversa (Linné)

Young larvae of T. perversa with a shell of 1 1/2 whorls were once found in June in plankton of Kazakh Bay. Later larvae of T. perversa with shells of 5-6 whorls have been found often in Sevastopol Bay in July and August. In Plymouth, according to Lebour (1933a), T. perversa reproduces from May to early fall.

According to Pelseneer (1926), T. perversa deposits gelatinous capsules in empty valves of lamellibranch mollusks.

Larvae of T. perversa, on emergence from the egg mass, have a sinistral shell with one whorl. These sinistral larvae clearly distinguish Triphora from larvae of other prosobranch mollusks (larval shells of all other Prosobranchia are twisted to the left and shells of Opisthobranchia to the right). The diameter of the shell, according to Lebour (1933a), is 160. The shell is brownish and rather thick. The shell of young larvae of T. perversa has a very characteristic sculpture in the appearance of numerous, very coarse tubercles (Fig. 9 α and δ). The velum is bilobed and colorless. The larvae of T. perversa we collected in Kazakh Bay were significantly smaller than larvae in Plymouth. The diameter of shells reached 150 at 1 1/2 whorls.

Larvae of T. perversa with 6 to 7 whorls and reaching a size of 600-700 (Fig. 9 β) are often found in plankton. The first complete whorl of such a shell has the characteristic tubercles, and the next coils are provided with a small keel from which go up and down lateral ribs. Shells are twisted to the left. Vela of the larvae are colorless. Larvae with shells of 7 to 7 1/2 whorls settle to the bottom.

Bittium reticulatum (Da Costa)

Larvae of B. reticulatum appear in abundance in the plankton of Sevastopol Bay. They are found in plankton samples, especially in June to December. In Karadag, according to Vinogradova, B. reticulatum reproduces from May to August, and larvae are found in the plankton from June to October. In Naples B. reticulatum reproduces from January to May (LoBianco, 1909), at Plymouth in July (Lebour, 1936); on the Danish coast larvae of B. reticulatum are found in the plankton, according to Thorson (1946), from the end of July to November.

Egg masses are deposited in spiral, twisted, mucous strings, fastened to the substrate. Eggs are white, with a diameter of 60-65. Eggs are covered with a transparent membrane; diameter of the egg with membrane is 95-110.

Upon hatching from the egg mass, the larva has a transparent shell with one whorl (Fig. 10 а). The velum is weakly developed with rudimentary lobes, but the digestive system is fully formed. The height of the shell of a hatched larva is 95-100. According to Thorson, on the Danish coast larvae hatch at a larger size, 170. After 3 to 4 days, larvae acquire traits characteristic for larvae of B. reticulatum often found in the plankton. Shells become slightly brownish. On the base of the shell are formed wide dark-brown bands very characteristic of larvae of B. reticulatum. The velum of such a larva is bilobed and colorless. The outer edge of the shell is produced into a "rostrum" (Fig. 10 б).

Larvae with a shell of 1 1/2 to 1 3/4 whorls, found in the plankton, have a brownish shell with an overall diameter of 190. The first whorl of the shell is smooth; later the shell is studded with fine, black dots. The outer edge of the shell takes on the appearance of a long, sharp "rostrum" (Fig. 10 в and г).

Before settling, larvae have still darker shells of 2 1/2 whorls. Height of the shell is 320-330. The last whorl has three lateral ribs. There are fine, black dots between ribs. The columella of the shell is dark brown. The outer edge of the shell has a large, rectangular protuberance (Fig. 10 д and е). The velum, as in all larvae, is completely colorless, with right lobe somewhat larger than the left.

Nassa reticulata (Linné)

Eggs are deposited in flat, vase-shaped, membranous capsules with a broadened base with which the capsule is attached to the substrate. The height of the capsule is 4.0-4.8 mm. In each capsule are 50-100 eggs of a pinkish color, rich in yolk. Lebour (1937) for Plymouth and Vinogradova (1950) for Karadag say that the size of eggs of N. reticulata reaches 120-160. According to our observations, eggs of

N. reticulata in Sevastopol are larger--up to 230-250. Egg capsules are attached to various firm objects--shells of mollusks, stones, or Cystoseira.

According to Lebour (1931), the period of embryonic development of the Atlantic form of N. reticulata from the egg capsule to appearance of the veliger lasts 3-4 weeks. Development of the Black Sea form, according to Bekman (1941), goes twice as fast at the same temperature. Our observations confirm the shorter period of embryonic development of N. reticulata in the Black Sea.

At the moment of hatching from the egg capsule, the larva has a transparent, colorless shell with one whorl (Fig. 11 α). The height of the shell is 280-300. The velum is bilobed with a narrow, reddish-brown pigment band. The digestive system is fully formed, with the mouth opening leading into the wide esophagus; the stomach, like the esophagus, lacks pigment and has long cilia inside. Two lobes of the liver are located beside the stomach.

A very characteristic feature of the Nassa larva is the dark pigment of the gut. Young larvae of Black Sea Nassa are similar in morphological features to larvae of Atlantic Nassa. The observations of Bekman that larval Black Sea Nassa lack pigment on the velum, and in this are distinguished from those of the Atlantic, is not verified, as Vinogradova has shown (1950).

Before settling in the Black Sea, larvae of N. reticulata have a shell with 1 3/4 whorls (Fig. 11 δ). The shell edge projects in a conspicuous process. Height of the shell is 700. Shells are transparent, colorless, smooth, and lack any kind of sculpture. The velum is bilobed but each lobe has a shallow constriction in the middle and is divided into two small lobes. There is a narrow, brown pigment band on the edge of the velum. Anteriorly between two lobes of the velum is a black pigmented spot. In the middle of the foot is a pale pigment spot. At Plymouth, according to Lebour (1937), at the end of the pelagic life the larval shell had 3 whorls and measured 720-800. Thorson (1946) also reported larvae of N. reticulata with 3 whorls reaching the same size in the Oresund. Apparently, in the Black Sea larvae of N. reticulata settle considerably earlier than in the Atlantic and shells with 3 whorls are characteristic for young mollusks (Fig. 11 β).

Rapana bezoar (Linné)

Larvae of Rapana are found in plankton in Sevastopol Bay from July to October. Capsules have the appearance of leathery brushes, parchment-colored, joined at the base in a continuous band. The height of each capsule is 12-16 mm.

On emerging from the capsule, the larva has a bilobed, colorless velum. The shell of the larva is brown with 1 1/4 whorls; the surface

of the shell is covered by dark tubercles (Fig. 12 α). The larvae have two otoliths, two eyes and only one true tentacle. The digestive system of the larva is fully formed at emergence from the capsule. It consists of a long esophagus; a strongly pigmented, black, bulky stomach; two long livers (larger and smaller); and pigmented intestine. The yolk survives as a large mass lying near the stomach. The diameter of the shell of the larva is 400.

Late larvae of Rapana before settling have shells of 2 1/2 whorls (Fig. 12 δ and β). The shell is brown with dark tubercles, height 900, with the lower end of the aperture extended into a siphonal canal. The velum consists of four long, colorless lobes.

Drapkin (1950) and Chukhchin (1957) described larvae of R. bezoar just emerged from the egg capsule in the Black Sea. Hirase (1928) described the same larvae as R. thomasiana (R. bezoar) from littoral waters of Japan. Larger late stages of the developing larvae with shells of 1 1/2 whorls were described by Chukhchin (1957). There are no descriptions in the literature of still larger late larvae of Rapana.

Caecum trachea (Montagu)

Larvae of C. trachea are found in plankton samples collected in Sevastopol from June to September. At Karadag, according to Vinogradova, larvae of C. trachea are found from April to August. With us, C. trachea failed to produce egg capsules. In the plankton, larvae are found with shells of from 1 1/2 whorls and diameter of 230 up to shells with 2 whorls and diameter of 290 (Fig. 13 α and δ). Described larvae have characteristic flat-spiral, colorless, transparent shells. The velum is bilobed and colorless. The digestive system is well developed; stomach very large and elongated, with walls covered with black pigment; liver greenish, large. Larvae with two shell whorls settle and crawl about. There are no descriptions of the larvae in the literature.

Cythara sp.

Larvae of Cythara sp. were found in Sevastopol Bay in July. The larvae have transparent, colorless shells with two whorls (Fig. 14). The lower end of the shell is drawn out into a large siphonal canal. The height of the shell is 680. The velum of the larva is large and bilobed. Sometimes a constriction develops in the middle of each lobe and the velum becomes 4-lobed. On the edge of the velum is a row of square white pigment spots. On the surface of the transparent velum are scattered separate grains of white pigment. The foot of the larva is small, tapering at the end and lacking an operculum. Vinogradova (1950) came upon the same larva at Karadag, but she described it as a prosobranch.

Odostomia acuta Jeffreys

The larvae of O. acuta were described by Thorson (1946).

Larvae of O. acuta were found by Thorson in plankton of the Oresund in December. They had shells of 2 to 2 1/2 whorls, height of 320 and width of 270 (Fig. 15 a, δ and σ). The shell was transparent, liver greenish-brown. It had an excretory organ of sealing-wax red, two black eyes and statocysts. The foot had characteristic bluish-black pigment. The velum was colorless.

Eulimella pointeli de Folin

E. pointeli bred in our aquaria in June. It deposits an egg mass appearing as a small heap of egg capsules individually fastened to the walls of the aquarium. The diameter of the egg capsules is 100. Each capsule contains one egg, diameter 90.

The shell of larvae emerging from egg masses has a wavy surface covered by fine tubercles (Fig. 16 a). The shell is sinistral, expanded, with a diameter of 120.

The velum of the larva is bilobed and colorless. Posteriorly on the upper side of the larva is located a round, strongly light-refractive, colorless body--the anal kidney. The digestive system is well developed. The stomach is rounded, colorless; the intestine has one curve and is not pigmented.

Since larvae settle when the shell attains 1 1/2 whorls, the complete shell of the mature larva has 1 1/2 whorls (Fig. 16 δ and σ); diameter of the larval shell is 180.

No information is given in the literature about the reproduction of E. pointeli.

Eulimella acicula (Philippi)

The larva of E. acicula (Fig. 17) is described by Thorson (1946).

Young larvae of E. acicula from plankton have a transparent, colorless shell of two whorls, height 220 and width 175. The color of the liver varied from olive-green to bluish-gray. Larvae have a reddish-brown excretory organ, two otoliths, but no eye at this stage. The velum is bilobed with the left lobe larger than the right. At the edges of the lobe there is a reddish purple pigment.

Late larvae from the plankton have a transparent shell, height 330, yellowish-brown liver, and two small eyes. The excretory organ is lacking.

Turbonilla sp.

Larvae of Turbonilla sp. are found in plankton of Sevastopol Bay in August and September. These larvae have transparent sinistral shells of two whorls (Fig. 18 а and б). The shell is 340 high, with the aperture expanded. The velum is bilobed and colorless. Larvae have a very characteristic, large, rounded, black anal kidney. The liver is black. Larvae caught in plankton settled and transformed into young mollusks. At settlement, these larvae had shells with two whorls.

Young mollusks from these larvae had short, blunt tentacles and very large eyes close together. The liver of the young mollusks was branching and black. In mature Black Sea Turbonilla delicata and T. pupeiformis, the top of the shell bears a prodissoconch larval shell of two whorls.

There is no information in the literature about reproduction in T. delicata and T. pupeiformis.

Parthenia emaciata (Brusina)

P. emaciata bred in our aquaria in June at a temperature of 19-20°C. It deposits separate oval egg capsules attached to the substrate in small groups. The diameter of the egg capsule is 130. Each capsule contains one white egg with a diameter of 60-70. Larvae emerge from the capsule after seven days.

Young larvae on emergence have a colorless, smooth, sinistral, expanded shell with one whorl and a diameter of 120 (Fig. 19 а and б). The velum is bilobed and colorless. The digestive system is completely formed and unpigmented. The stomach is rounded; the intestine has two loops. Otoliths are large. Posteriorly on the upper part of the larva is located a large oval body, the anal kidney. Larvae with a shell having 1 1/2 whorls settle on the bottom and the top of the shell of metamorphosed young retains the prodissoconch shell of 1 1/2 whorls. There is no information about reproduction of P. emaciata in the literature.

Parthenia costulata Milaschewitsch

P. costulata bred in our aquaria in June at a temperature of 20-22°. They deposited separate oval egg capsules attached to the substrate and assembled in small groups. The diameter of the egg capsule is 130. Each egg capsule contains one egg 67 in diameter. Late larvae of P. costulata were found in the plankton of Sevastopol Bay from June to August.

Larvae just hatched from egg capsules have a transparent, sinistral expanded shell (Fig. 20 а), 120 high and 34 wide. The velum

is small, bilobed and colorless. The digestive system is completely formed and not pigmented; the stomach is thick-walled, rounded and colorless; the intestine is also unpigmented. The otoliths are large. In the upper right angle of the larva is located a large, black formation--the anal kidney.

Before settling, larvae of P. costulata have a colorless, sinistral shell of 1 1/2 whorls (Fig. 20 δ and ∂). The orifice of the shell is slightly dilated. The velum is bilobed and colorless. The anal kidney appears as a large, rounded structure. The liver is greenish-yellowish. The top of the shell of mature P. costulata bears a larval shell of 1 1/2 whorls (Fig. 20 ε).

There is no information in the literature about reproduction of P. costulata.

Retusa truncatula (Bruguiere)

Larvae of R. truncatula are found in plankton of Sevastopol Bay from May to October. According to Rasmussen (1944), R. truncatula reproduces on the Danish coasts from May to July.

Eggs of R. truncatula are deposited in mucous strings twisted into balls and enclosed in a common mucous mass. Egg masses measure 3-5 mm. Eggs are white and each is covered with a transparent membrane. The diameter of an egg is 75-100, of the egg with membrane 150-180. Larvae emerge from the egg mass in 5-6 days.

Larvae on emergence from the egg mass have a transparent, expanded, sinistral shell with one whorl and a diameter of 120 (Fig. 21 α and δ). The velum is bilobed and lacks pigment. The larva has only one eye, on the left, and very large otoliths. The ciliated foot consists of large cells. The foot is tapered and sharply pointed beyond the operculum. The edge of the mantle has a reddish pigment. The digestive system is well developed and not pigmented. The liver is yellow-brownish.

Before settling, the diameter of the larval shell reaches 300 and the number of whorls increases to 1 1/2 (Fig. 21 β). The larva has two eyes. The velum is bilobed and colorless. The reddish pigment along the edge of the mantle becomes denser. The Black Sea larvae of R. truncatula are similar to larvae inhabiting the Danish coast (Rasmussen, 1944; Thorson, 1946).

Stiliger bellulus (D'Orbigny)

In our aquaria, S. bellulus bred from May to June. Egg masses have a spiral shape. Eggs are deposited in oval, transparent capsules, occurring in a common mucous mass. Diameter of the egg is 40, of egg capsule 94.

Larvae on emergence from the egg mass have a transparent, colorless, very expanded shell, with a diameter of 100-120 (Fig. 22 *а* and *б*). The velum is bilobed and colorless. Along the edge of the velum, at the base of the cilia are located round cells refractive to light. The large statocysts are located in the base of the fairly bulky foot. The esophagus is very thick and leads into the thick-walled stomach with a two-lobed liver. The one-looped intestine exits from the dorsal part of the stomach. Near the larval anus is located the large spherical black anal kidney. There are no descriptions of larvae of S. bellulus in the literature.

Limapontia capitata (O. F. Müller)

L. capitata bred in our aquaria in July. Limapontia deposits eggs on various algae. The egg masses are spherical or sausage-shaped, with a maximum diameter of 1-5 mm (Fig. 23 *а*). The diameter of the egg is 67. Eggs are covered with a transparent membrane and diameter of the egg with the membrane is 110. Eggs are enclosed in a rather dense gelatinous mass.

According to Thorson, larvae hatch in the lower Kattegat in 7-8 days at 15-17°. With us, hatching was advanced to five days at a temperature of 19-20°.

Larvae emerged from the egg mass have a sinistral, transparent shell of one whorl and a very wide aperture (Fig. 23 *б*). The surface of the shell is covered with small dots. Height of the shell is 90-100. The velum is colorless and bilobed and at its edge has a row of large cells strongly light-refractive. Otoliths are very large. The digestive system of the larva is well developed. There is black pigment around the mouth and glottis. In the Black Sea estuary, according to our data, the esophagus is also pigmented as well as part of the intestine bordering the stomach, which is bulky and colorless. The large liver has a conspicuous cavity. In the upper left side of the larva is located a large, black anal kidney.

Later larvae, taken in plankton samples gathered in Sevastopol Bay in April and May, had a sinistral, transparent, colorless shell of 1 3/4 whorls (Fig. 23 *в*). The diameter of the shell of such larvae is 280. The velum is bilobed with pigment bands consisting of dense aggregations of black pigment grains. There is a black anal kidney. In this stage larvae undergo metamorphosis. Larvae transplanted from the plankton after several days settle on the bottom of the vessel, lose the velum, and young mollusks creep, extending from the shell.

Descriptions of larvae of Limapontia for the Danish coast are given by Westergaard and Thorson (1938) and Thorson (1946). Mileikovskii (1958) has described larvae from the White Sea. Larvae of Black Sea L. capitata are quite similar to larvae of Limapontia from the North Sea and very different from larvae of White Sea Limapontia.

The latter, according to Mileikovskii, lack a black anal kidney; the velum of late larvae bears yellow pigment instead of black; and black pigment is accumulated on the foot.

Tergipes edwardsi Nordmann

T. edwardsi bred in our aquarium in August. Eggs are deposited in rounded mucous masses 750-950 in diameter. Eggs are white and covered with a transparent membrane and are 60-70 in diameter. Larvae emerge from egg masses after five days.

On emergence from the egg masses, larvae (Fig. 24) have a characteristic transparent shell, drawn out dorsoventrally. The body of the larva is located in the right side of the shell. The velum consists of two small, colorless lobes. The foot has an operculum. The digestive system is well developed; the intestine long, making two loops. From the body of the larva to the lower tip of the shell extends a muscle. In the upper right side of the larva appears the colorless, strongly light-refractive anal kidney resembling an oval body. A drawing of Black Sea larvae of T. edwardsi appears in the work of Nordmann (1845).

Tergipes adspersus Nordmann

T. adspersus bred in our aquaria in August. Egg masses are sausage-shaped, 1.4 mm long. Eggs are white, enclosed in transparent, colorless membranes and have a diameter of 60-70.

The veliger of T. adspersus (Fig. 25 a and б) does not emerge from the egg mass but proceeds to metamorphosis inside the mass. The veliger has a characteristic dorso-ventral elongation and a transparent shell. The body of the veliger is located in the top part of the shell. The velum consists of two small, colorless lobes; the foot has an operculum. Otoliths are large. The digestive system is well developed; the intestine long, making two loops. From the body of the larva to the lower end of the shell extends a long muscle.

Metamorphosis takes place inside the egg mass. The foot grows very wide and the operculum disappears; the body of the larva expands and fills almost all the shell. The velum survives in two small lobes. At this stage the young mollusk (Fig. 25в) may possibly emerge from the egg mass and swim for some time, but such a pelagic stage was not observed. There is nothing in the literature about the reproduction of T. adspersus.

Staurodoris bobretzkii Gadzikiewicz

S. bobretzkii bred in our aquaria in July. The egg mass has the appearance of a wide, yellow, twisted string fastened to the substrate

by one of the lateral edges. Larvae emerged from the egg mass after 8 days at 21-22°.

Upon emergence, larvae have a transparent, colorless, sinistral, very wide shell with a diameter of 150 (Fig. 26). The velum is bilobed and colorless. Otoliths are very large. The digestive system is well developed; the stomach is rounded and colorless; the intestine has one loop and is also colorless; the liver is yellowish. Near the anus in the upper right angle of the larva is located a large, colorless, transparent, strongly light-refractive anal kidney. There is no information in the literature about the reproduction of S. bobretzkii.

Larva A

Larva A (Fig. 27) was found in the plankton of Sevastopol Bay on 7 September 1956. The larva had a transparent, colorless, sinistral shell with widened aperture and one whorl. The shell was 210 high and 160 wide. The velum was bilobed and colorless. The foot was very large, pointed at the tip.

Larva B

Larva B (Fig. 28) was found in plankton at Sevastopol Bay on 26 June 1956. Larva had a shell with a very large, prolonged aperture; the length of the shell was 250. The velum was bilobed with square, reddish pigment spots arranged in one row along the edge. It had two eyes and two otoliths. The larva was lens-shaped; the digestive system was not developed; a very large part of the body of the larva consisted of a yellow mass.

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Captions of Figures

Fig. 1. Genus Gibbula. а , general view of larva of G. albida (Gmelin); б , larva of G. euxinica (Andrjewski); в , larval shell of G. euxinica.

Fig. 2. Phasionella pontica Milasch.

Fig. 3. Littorina neritoides L. а , shell of larva from the plankton; б , larva from plankton (after Lebour, 1935).

Fig. 4. Rissoa splendida Eichwald. а , egg capsule; б , larva at moment of emergence from egg capsule; в , shell of larva at moment of emergence from egg capsule; г , larva from plankton with shell of 2 1/2 whorls, bottom view; д , the same larva, top view.

Fig. 5. Rissoa venusta Philippi. а , larva at moment of emergence from egg capsule; б , shell of larva at moment of emergence from capsule; в , late larva from plankton at moment of "creeping."

Fig. 6. Cerithidium submammelatum. а , larva at moment of emergence from egg mass; б , shell of larva at moment of emergence from egg mass, side view; в , the same, front view.

Fig. 7. Cerithiopsis tubercularis Montagu. shell of late larva from plankton.

Fig. 8. Cerithium ponticum. а , larva at moment of emergence from egg mass; б , shell of larva at moment of emergence from egg mass; в , shell of larva 16 days old, side view; г , the same, front view.

Fig. 9. Triphora perversa. а , shell at 1 1/2 whorls of larva from the plankton, side view; б , the same, front view; в , shell of late larva from the plankton.

Fig. 10. Bittium reticulatum. а , larva 4 days old; б , shell of larva 4 days old, side view; в , the same, front view; г , shell of 1-whorled larva from the plankton; д , shell of 2-whorled larva from the plankton, top view; е , the same, bottom view.

Fig. 11. Nassa reticulata. а , larva at moment of emergence from the capsule; б, shell of late larva from the plankton; в , top of shell of young mollusk.

Fig. 12. Rapana bezoar. а , larva at moment of emergence from the capsule; б , late larva with shell; в , shell of late larva from the plankton.

Fig. 13. Caecum trachea. а , larva from the plankton, side view; б , shell of larva from the plankton, top view.

Fig. 14. Cythara sp. larva from the plankton.

Fig. 15. Odostomia acuta. а , б , larvae from the plankton; в , top of shell of mature mollusk (after Thorson, 1946).

Fig. 16. Eulimella pointeli. а , larva at moment of emergence from egg mass; б , в , top of shells of mature mollusks.

Fig. 17. Eulimella acicula. а , б , late larvae from plankton; в - д, young larvae from plankton; е - м, top of shell of mature mollusks (after Thorson, 1946).

Fig. 18. Turbonilla sp. а , larva from the plankton; б , shell of larva from the plankton.

Fig. 19. Parthenia emaciata. а , larva at moment of emergence from the egg capsule, front view; б , the same, side view.

Fig. 20. Parthenia costulata. а , larva at moment of emergence from the egg capsule; б , в , young mollusks obtained from pelagic larvae; г , top of shell of mature mollusk.

Fig. 21. Retusa truncatula. а , larva at moment of emergence from the egg mass; б , shell of late larva from the plankton; в , shell of young mollusk.

Fig. 22. Stiliger bellulus. а , larva at moment of emergence from egg capsule; б , its shell.

Fig. 23. Limapontia capitata. а , egg mass; б , larva at moment of emergence from egg mass; в , late larva from the plankton.

Fig. 24. Tergipes edwardsi. а , larva at moment of emergence from egg mass; б , the same, end view.

Fig. 25. Tergipes adspersus. а , veliger; б , veliger at moment of transformation into young mollusk; в , young mollusk emerged from egg mass.

Fig. 26. Staurodoris bobretzkii Gadzikiewicz.

Fig. 27. Larva A. а , general view of larva; б , shell, front view; в , the same, side view.

Fig. 28. Larva B.

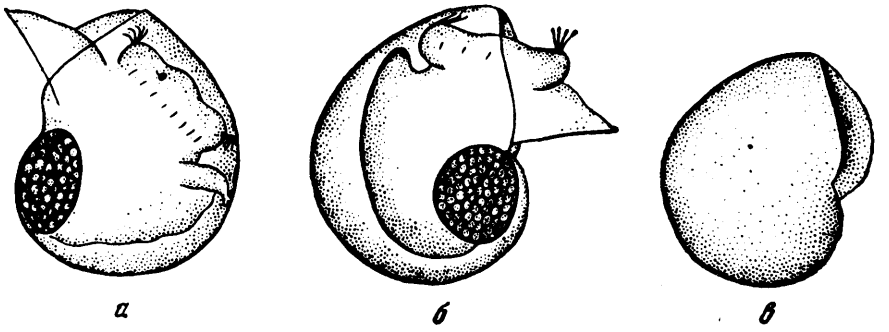


Рис. 1. Род Gibbula.

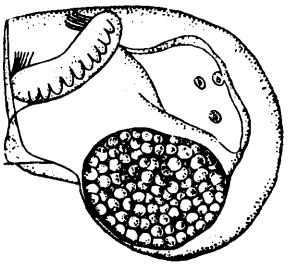


Рис. 2. Phasionella pontica Milasch

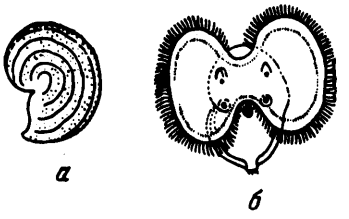
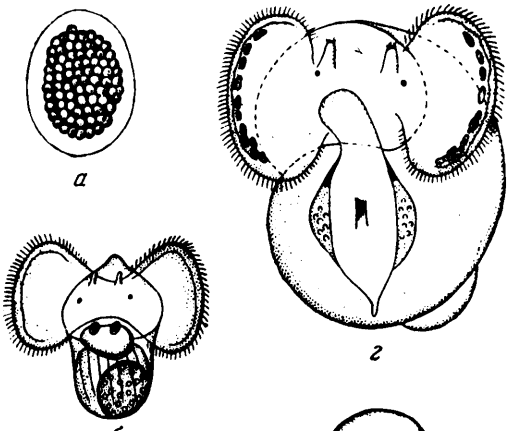


Рис. 3. Littorina neritoides L.



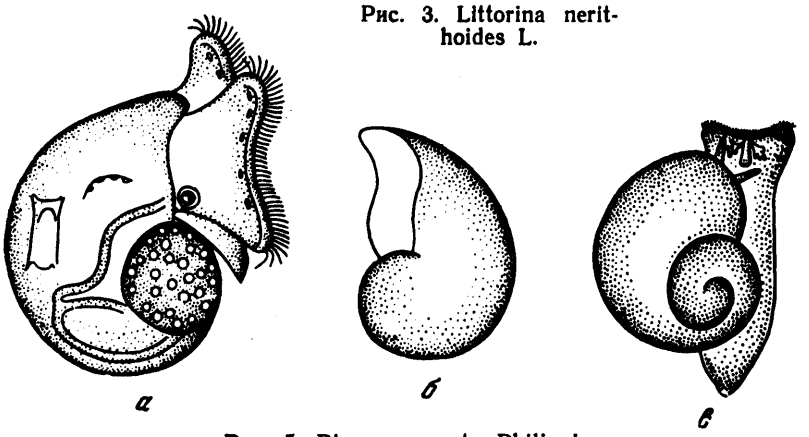


Рис. 5. Rissoa venusta Philippi.

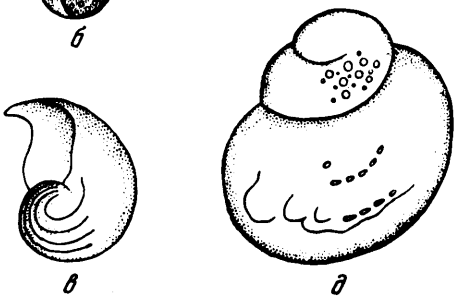


Рис. 4. Rissoa splendida Eichwald

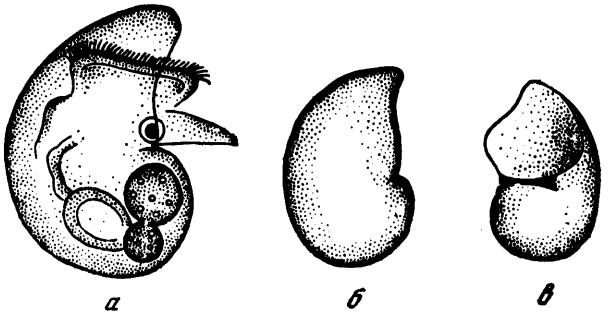
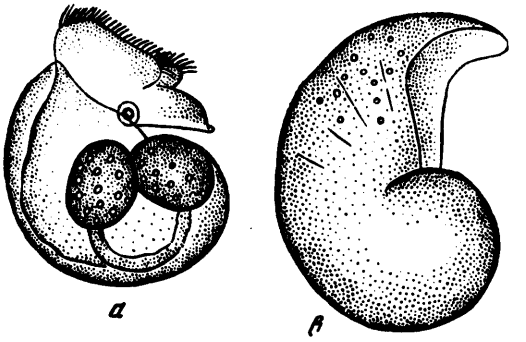


Рис. 6. Cerithidium submammelatum



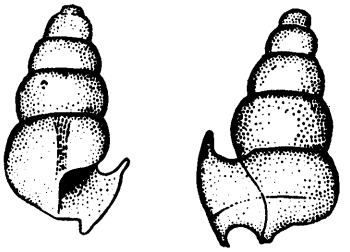


Рис. 7. Cerithiopsis tuberculoris

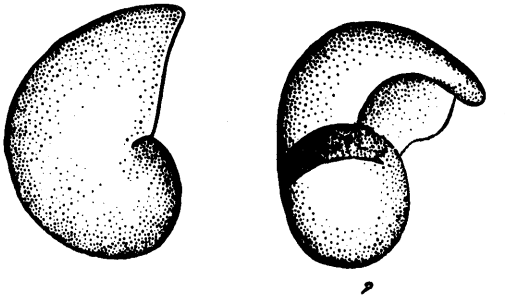


Рис. 8. Cerithium ponticum

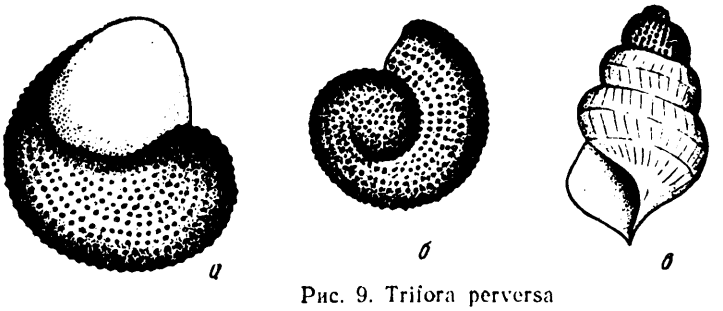


Рис. 9. Trifora perversa

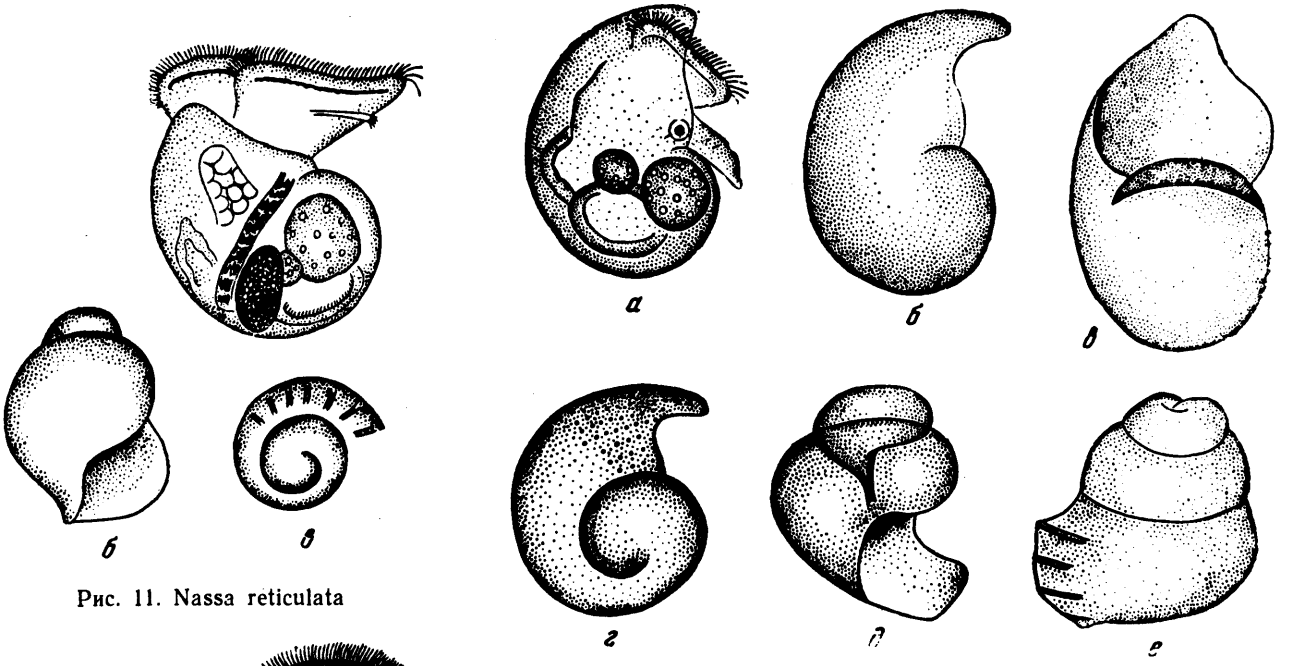


Рис. 11. Nassa reticulata

Рис. 10. Bitium reticulatum

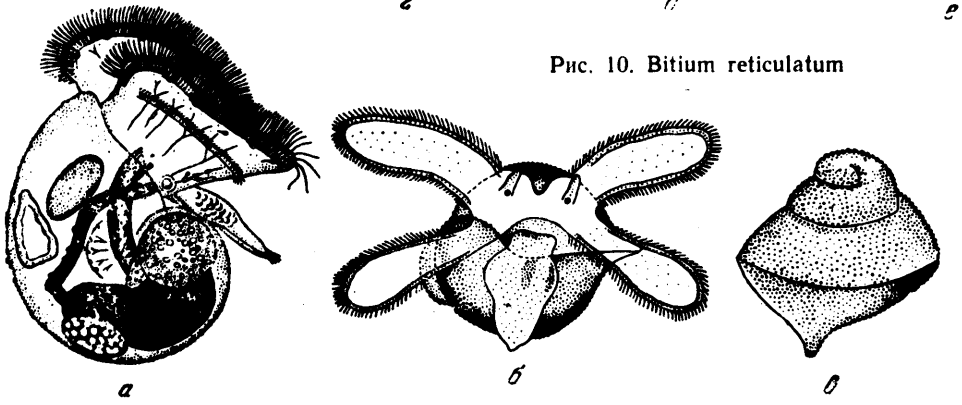


Рис. 12. Rapana bezoar

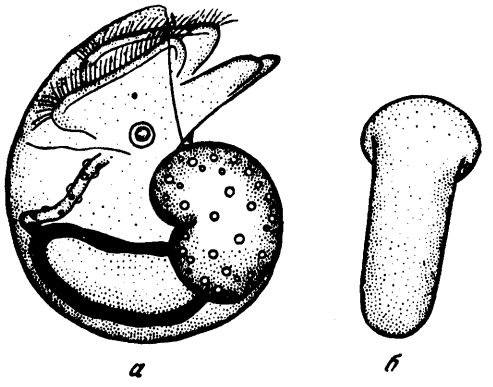


Рис. 13. Caecum trachea

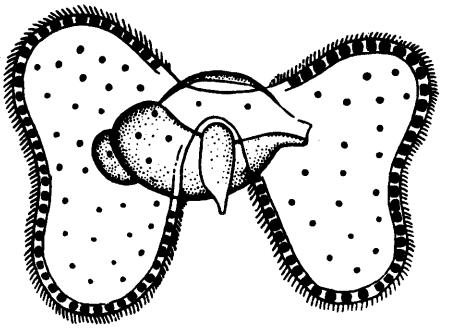


Рис. 14. Cythara sp.

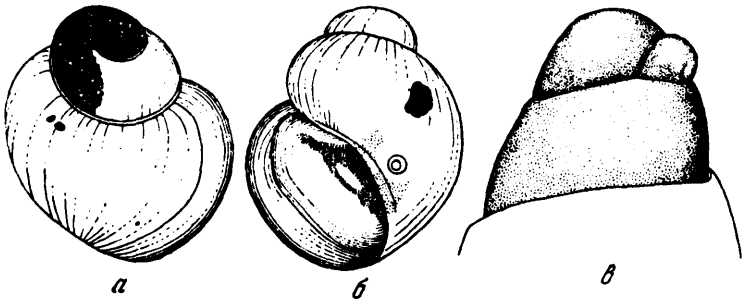


Рис. 15. Odostomia acuta

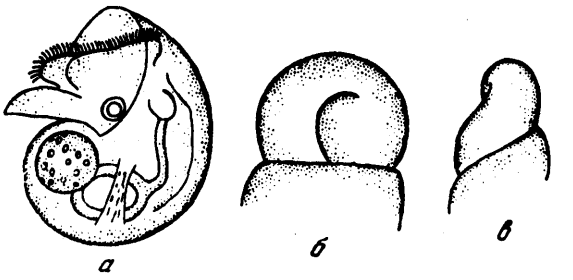


Рис. 16. Eulimella pointeli

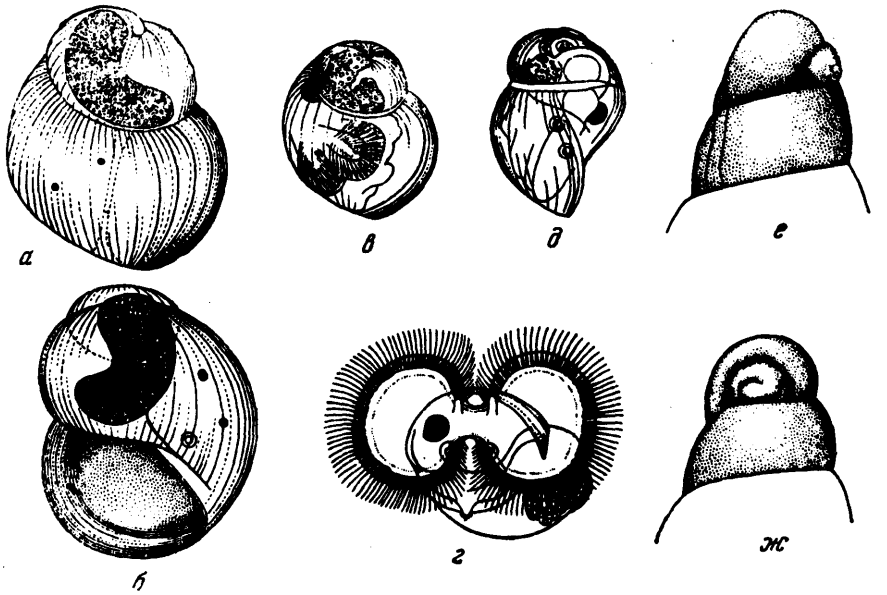


Рис. 17. Eulimella acicula

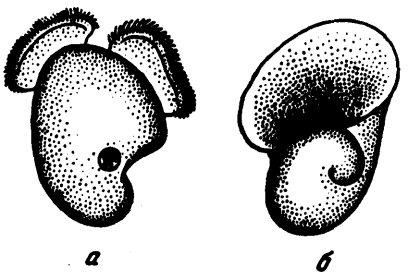


Рис. 18. Turbonilla sp.

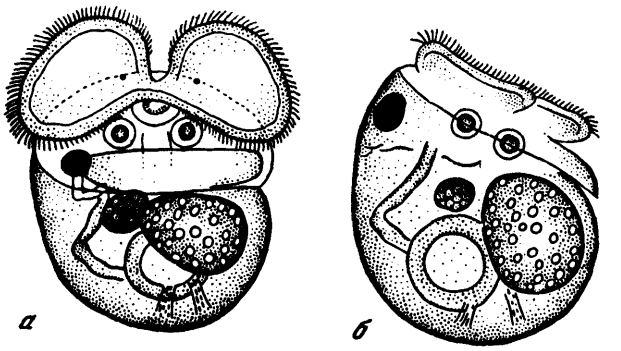


Рис. 19. Parthenia emaciata

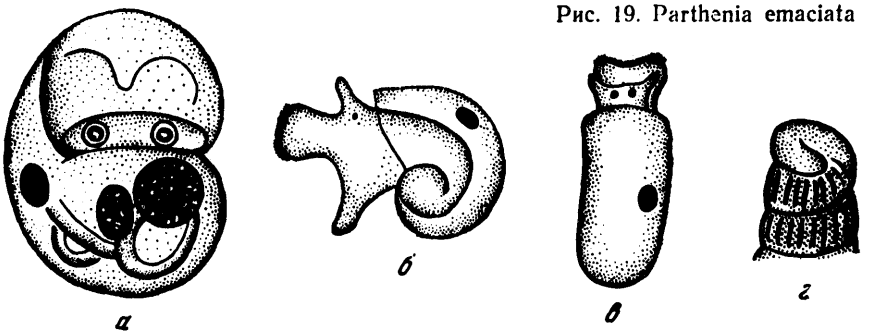


Рис. 20. Parthenia costulata

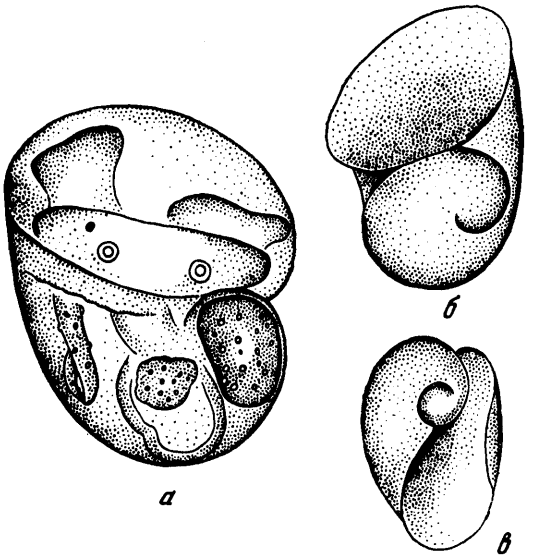


Рис. 21. Retusa truncatula

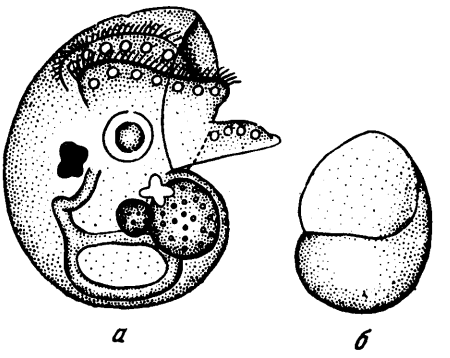


Рис. 22. Stiliger bellulus

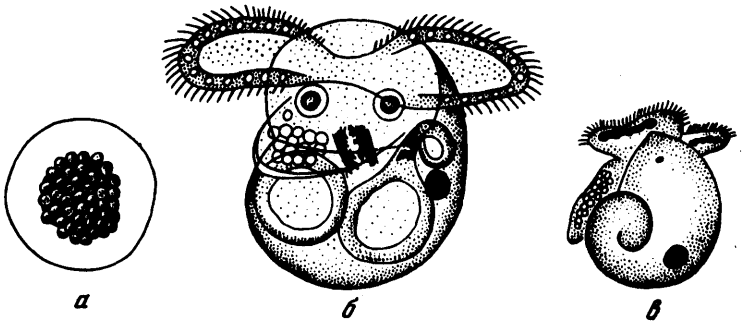


Рис. 23. Limapontia capitata

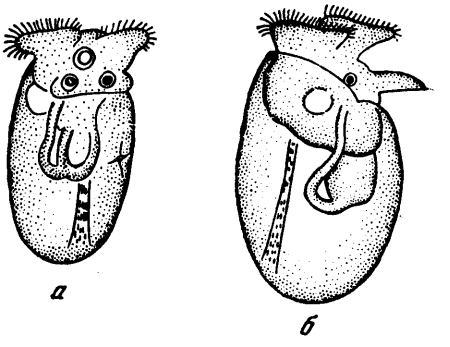


Рис. 24. Tergipes edwardsi

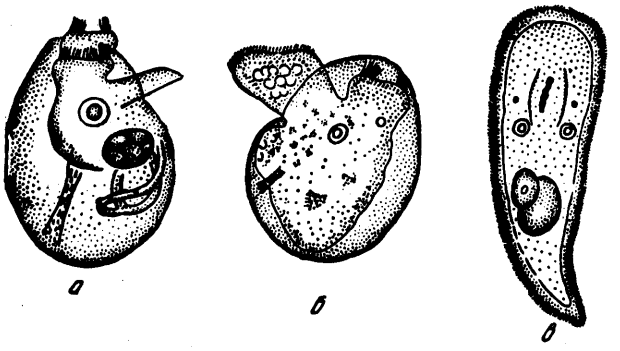


Рис. 25. Tergipes adspersus

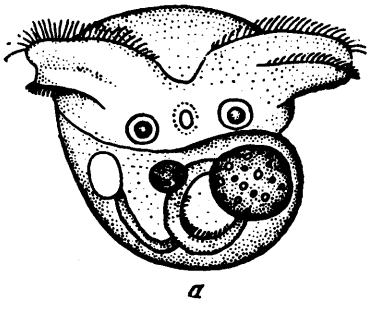


Рис. 26. Staurodoris bobretzkii Gadzikiewicz

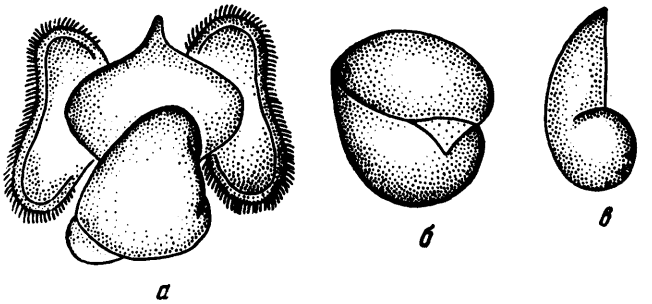


Рис. 27. Личинка А.

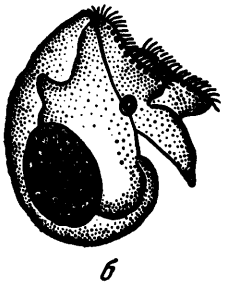


Рис. 28. Личинка В